Energy and Work

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Materials for today’s meeting

Please rename yourself with your First name and the Country

Activities for today

OALG Chapter 7 Final.docx click on this link and make sure that the document is open during the whole meeting

Version for teaching in person:

https://docs.google.com/document/d/1_Sd6MWLbqs3Jfcmj25ggnQGOYR_GGHn2/edit

Folder with all resources for the meeting, including American Journal of Physics papers https://drive.google.com/drive/folders/1SuyazPT_viM-x9Mx_BWfXP5FK23JI5vB

What did you observe?

The difference between going up and down stairs?

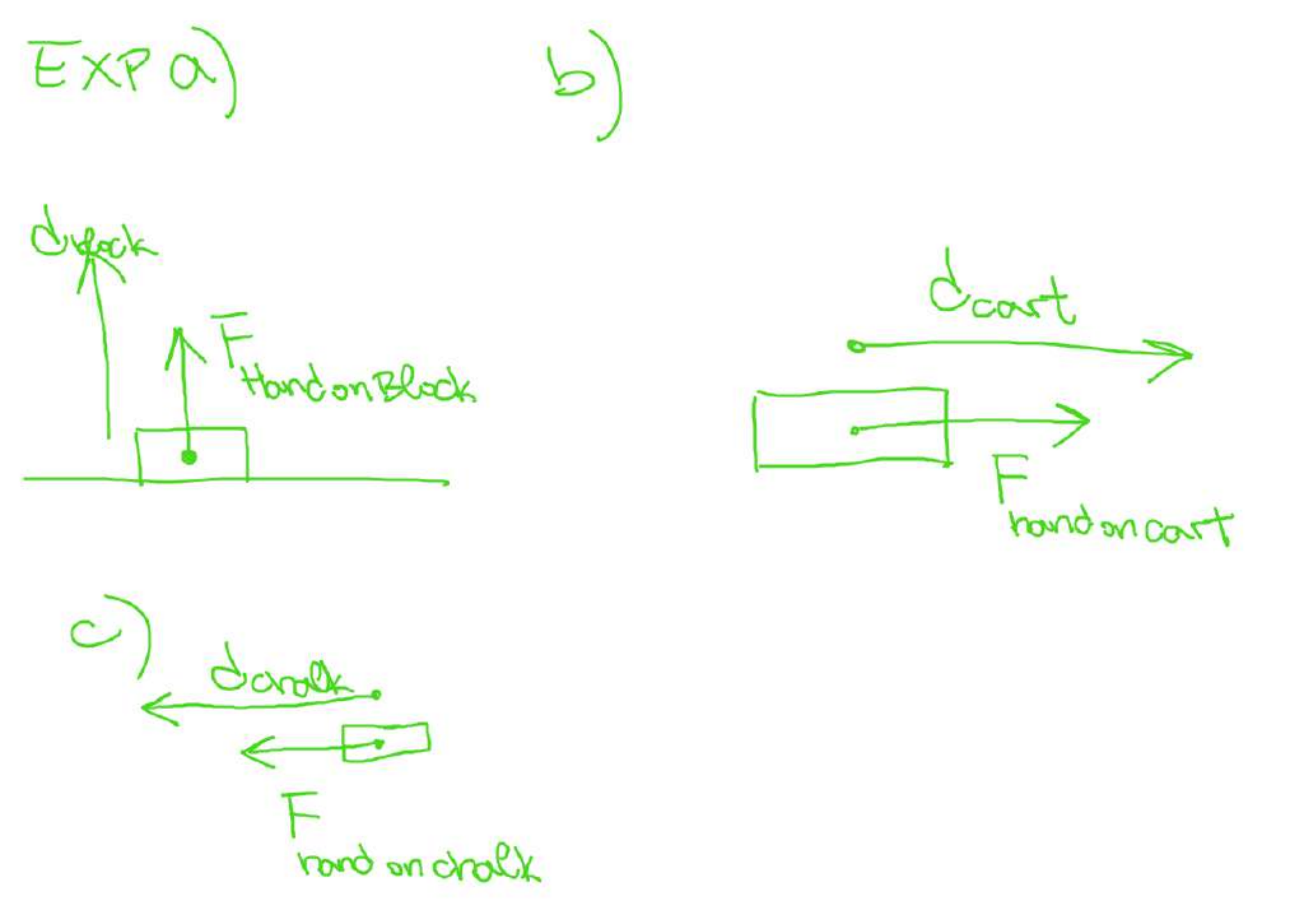
What toys did you find?

All together 7.1.1. A, b, c

https://mediaplayer.pearsoncmg.com/assets/_frames.true/secs-experiment-video-13

Pay attention to what we include in the system and what the external objects are.

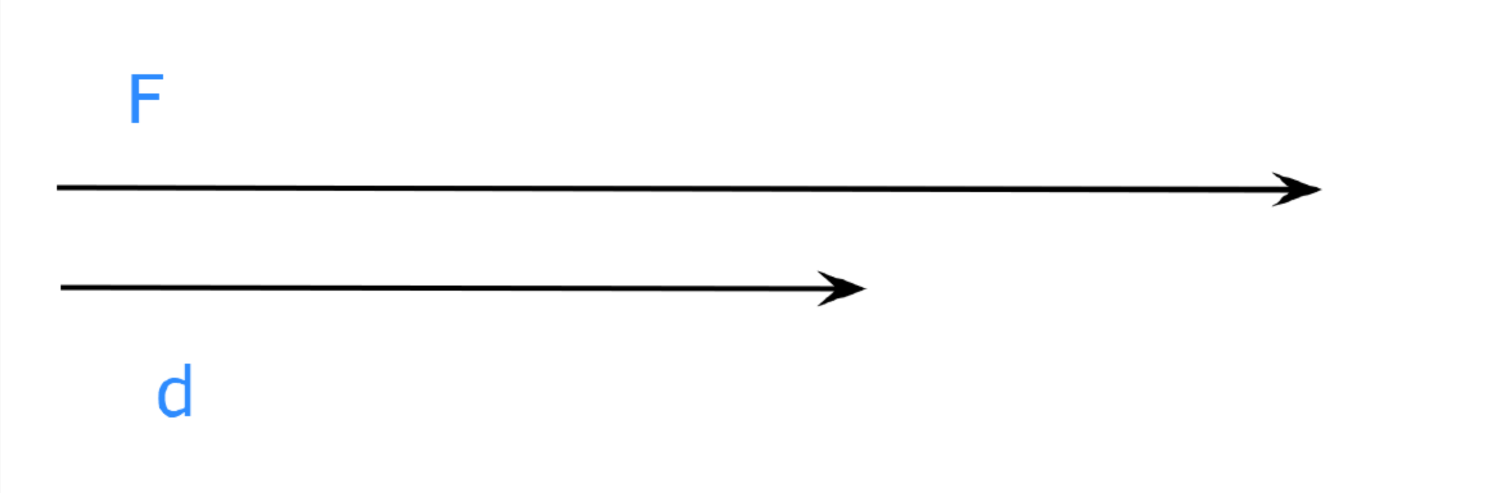
Team 1.7.1.1 d

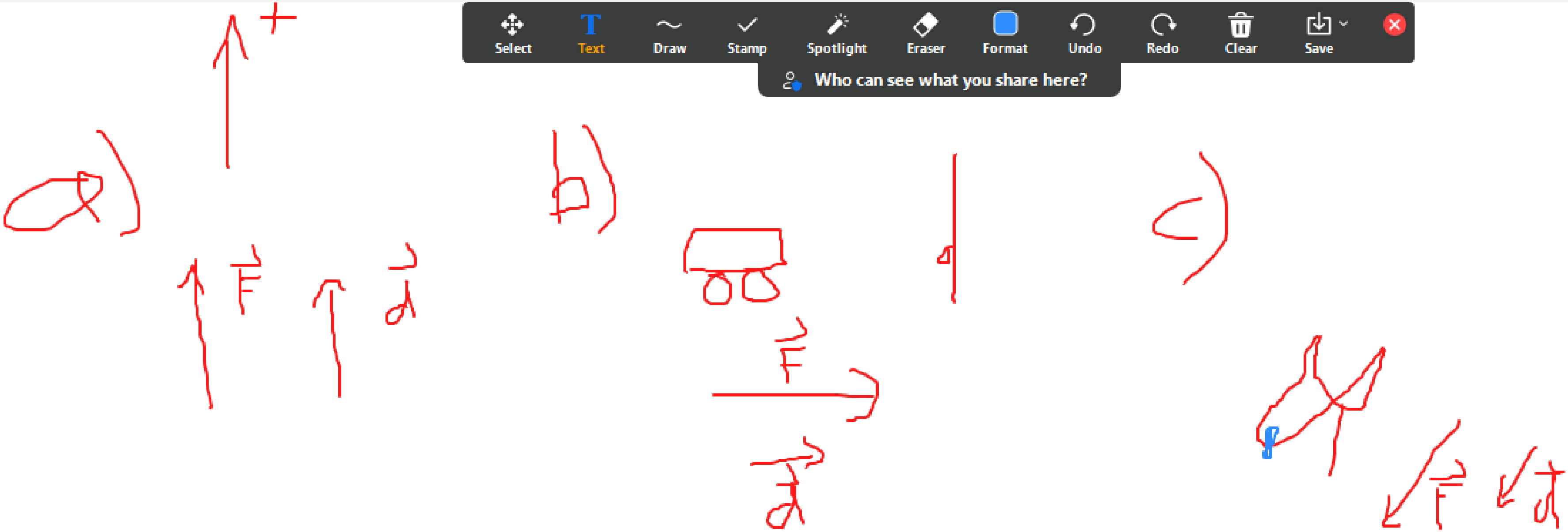


EXP a)
b)
d block
F Hand on Block
d cart
F hand on cart
c)
d chalk
F hand on chalk

Team 2 7.1.1 d

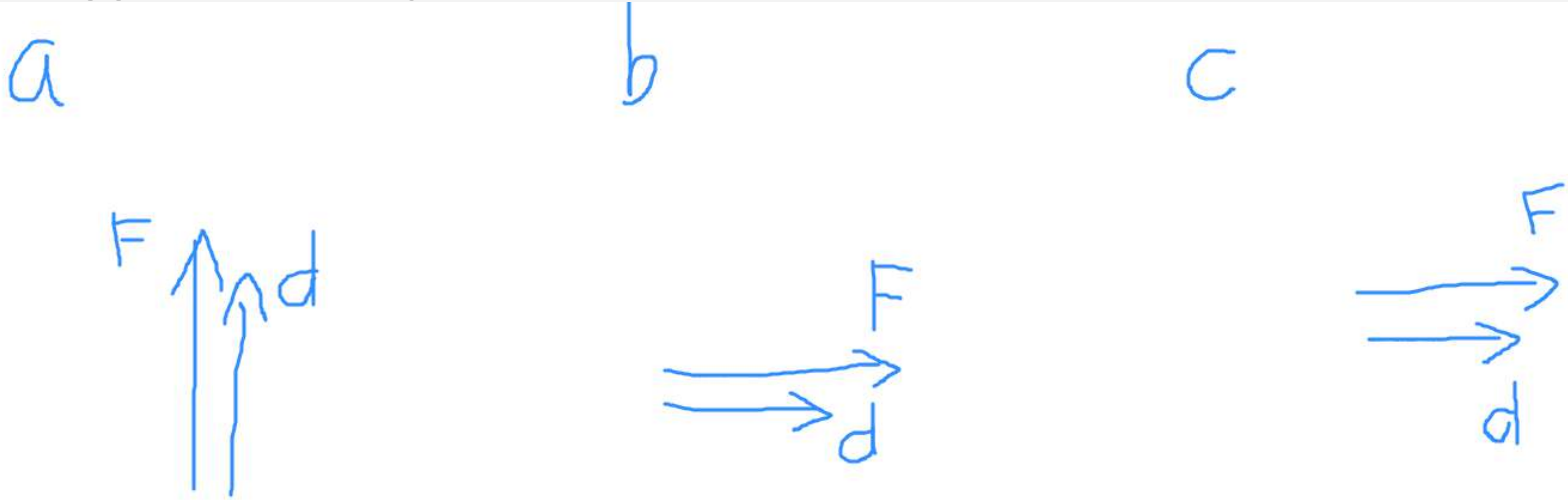
We exert a force on a part of the system and move it in the same direction as the force





The pattern: In all 3 cases, the CCA increased if the Force extertted onto the system and the displacement of the system point in the same direction. They are proportional.

Team 4 7.1.1 d



$$[F \cdot d] = Nm > 0$$

$5 \times 3 =$
$5 + 5 + 5$

$[N] \quad [m]$

All together 7.1.2 experiments 1 and 2

https://mediaplayer.pearsoncmg.com/assets/_frames.true/secs-experiment-video-14

$\vec{F} \cdot \vec{d}$ ccA

↑ ↓

↑ →

↑ ↓ 0

Fd ↑↑ $\theta = 0$

$-Fd$ ↑↓ $\theta = \pi$

0 ↑⊥ $\theta = \frac{\pi}{2}$

$[\text{Work}] = \text{Nm}$

All together 7.1.3 experiment 3

https://mediaplayer.pearsoncmg.com/assets/_frames.true/secs-experiment-video-14

Team 1 7.1.4

Team 2 7.1.4

Team 3 7.1.4

Team 4 7.1.4

All together 7.1.5

https://mediaplayer.pearsoncmg.com/assets/_frames.true/sci-OALG-7-1-5

Team 1 7.1.6

A) Elevation
B) Speed
C)

Team 2 7.1.6

a. Increased CCA of the brick due to height above the Earth
b.

Team 3 7.1.6

a. Gravitational force change
b. Velocity change
c. Change of how much something is stretched (elastic force change)
d. Change due to friction force

Team 4 7.1.6

Force and distance (work) creates a change

a. The altitude increased
b. The velocity increased
c. The slingshot stretched longer
d. The temperature increased
e.

Gravitational potential energy

Kinetic energy

Elastic energy

Internal energy

Team 1 7.1.7

A) Kick a football with our foot
B) Pulling a child in a sled with a rope at an angle with the direction of displacement
C) Stopping a child on a tricycle to prevent a crash
D) Carrying travel bags

Team 2 7.1.7

a. Pushing a shopping cart
b. Pushing a marble
c. Bicycle brakes
d. Eugenia on roller skates going in circle

Team 3 7.1.7

a) Bouncing a ball (when pushing down on it)
b) Same as in a) but with less force
c) Same as in a) but right as it comes back up after bouncing off the floor (when we are catching it)
d)

Team 4 7.1.7

a. A person pushes a box full of books and it moves in the direction of the push

b.A person pushes an empty box and it moves in the direction of the push

C. Stopping a moving object like a ball

d. Person carries bag of groceries horizontally

All together 7.1.8

https://mediaplayer.pearsoncmg.com/assets/_frames.true/sci-OALG-7-1-8.

Team 1 7.2.1 for d use the link provided in the text

https://mediaplayer.pearsoncmg.com/assets/_frames.true/sci-OALG-7-2-1.

Team 2 7.2.1 for d use the link provided in the text

https://mediaplayer.pearsoncmg.com/assets/_frames.true/sci-OALG-7-2-1.

a. **The height of the car does not change. Because it land in the can every time it has the same speed at the bottom of the ramp. Gravitational potential energy changes into kinetic energy.**

Team 3 7.2.1 for d use the link provided in the text

https://mediaplayer.pearsoncmg.com/assets/_frames.true/sci-OALG-7-2-1.

a) **The angle of the ramp changes but the initial height (initial potential energy stays unchanged) stays the same. Regardless the car always hits the bin. Since the initial energy of the system is always the same, the car always has the same velocity when it leaves the ramp so it always hits the bin.**

Team 4 7.2.1 for d use the link provided in the text

https://mediaplayer.pearsoncmg.com/assets/_frames.true/sci-OALG-7-2-1.

The track is made steeper, but the starting height of the car stays the same. Since the starting height is always the same, the car always starts with the same gravitational potential energy, which is then converted to kinetic energy, and so in all cases the car has the same velocity as it leaves the table.

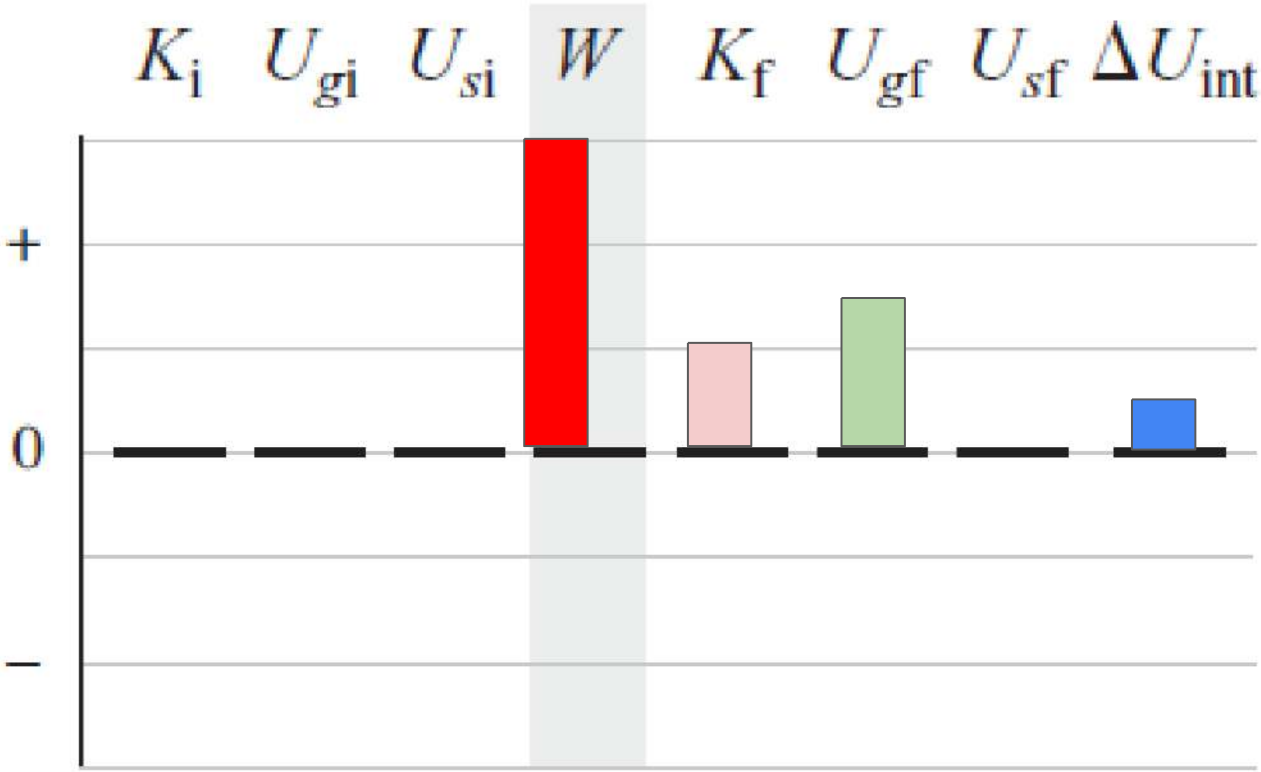
Can we think of total energy as a conserved quantity?

How can we write the energy conservation relation similar to the one we wrote for momentum?

When is the total energy of a system constant?

When is the total energy conserved?

All together 7.2.2



Team 1 Modified 7.2.3

7.2.3 Represent and reason

Below you read the descriptions of two experiments.

a. Draw a sketch showing initial and final states.

b. Construct a qualitative work-energy bar chart for each of the systems listed below.

Experiment 1: You are lifting a heavy suitcase at constant speed. Initial state: The suitcase is right above the ground.   Final state: The suitcase is moving at a distance y above the ground.

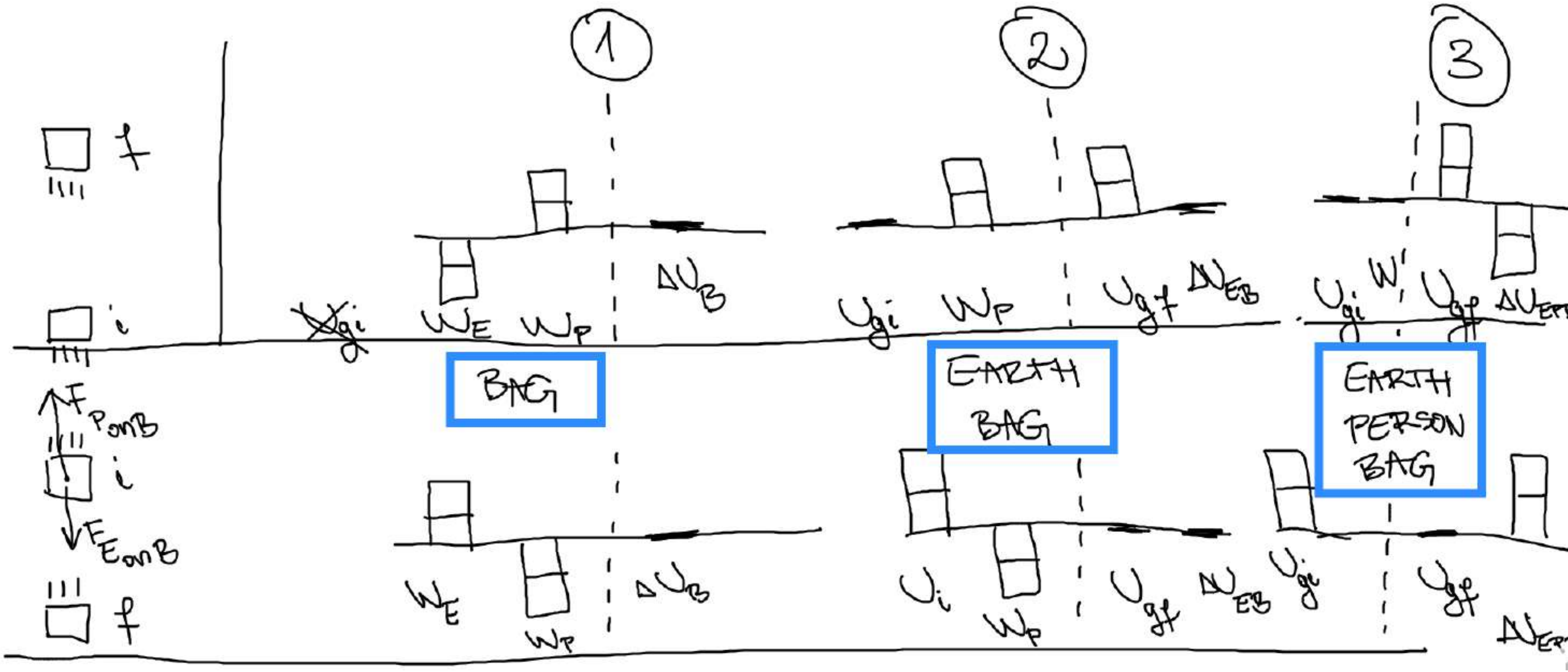
Experiment 2: You are lowering a heavy suitcase at constant speed. Initial state: The suitcase is above ground. Final state: the suitcase is near the ground.

System 1: The suitcase (Earth does work on the suitcase here).

System 2: The suitcase and Earth.

System 3: The suitcase, Earth and you.

Team 1 Modified 7.2.3



Team 2 Modified 7.2.3

7.2.3 Represent and reason

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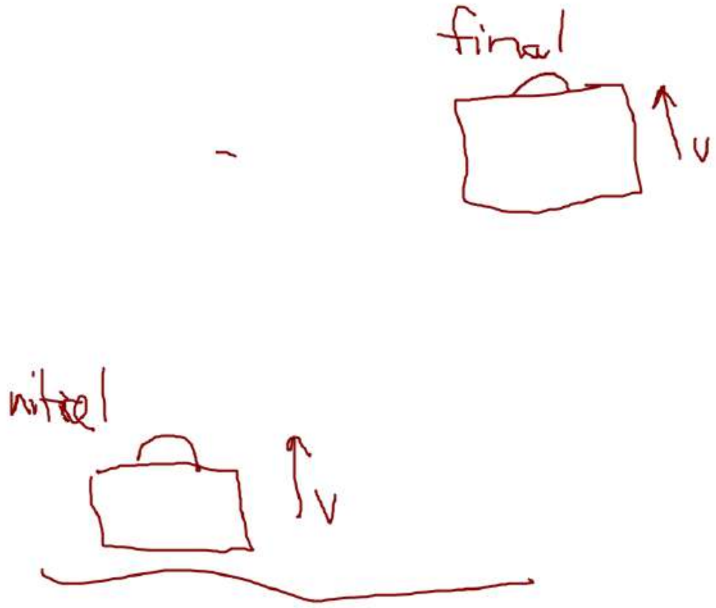
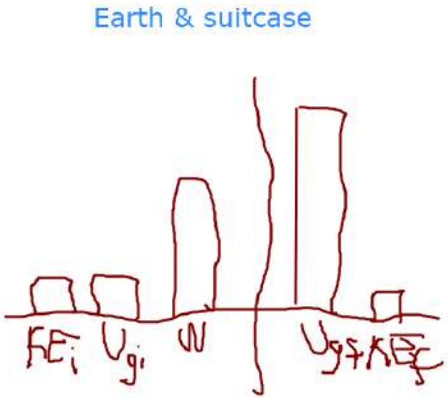
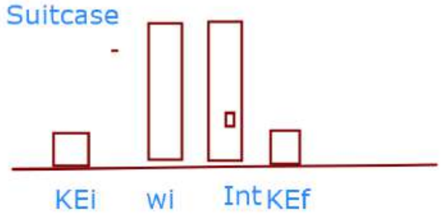
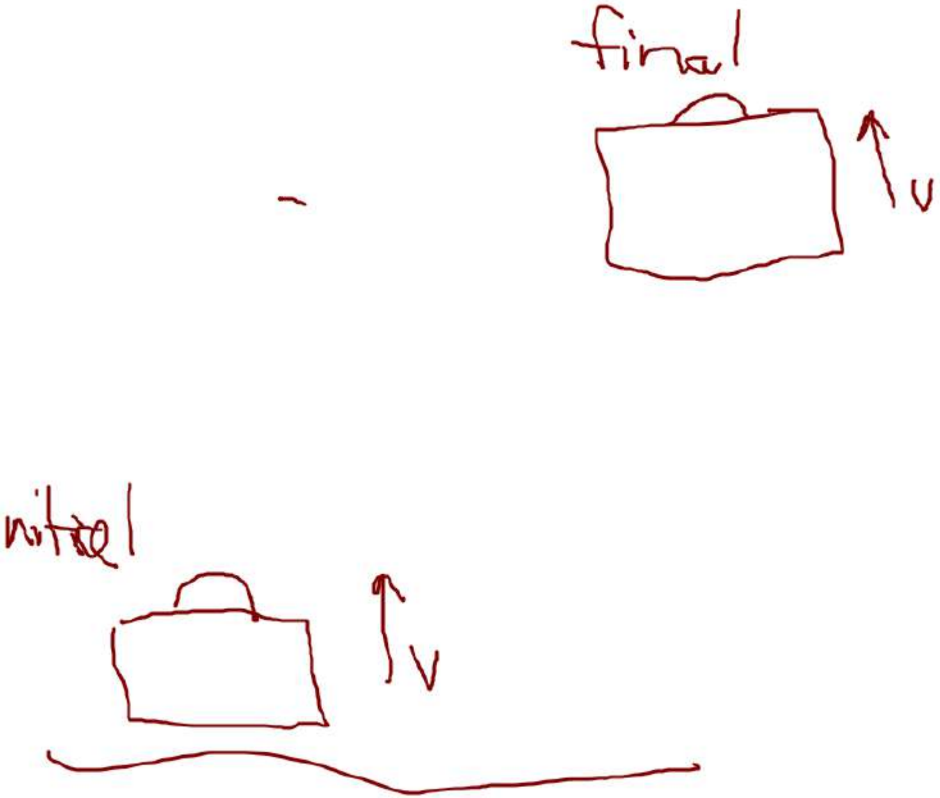
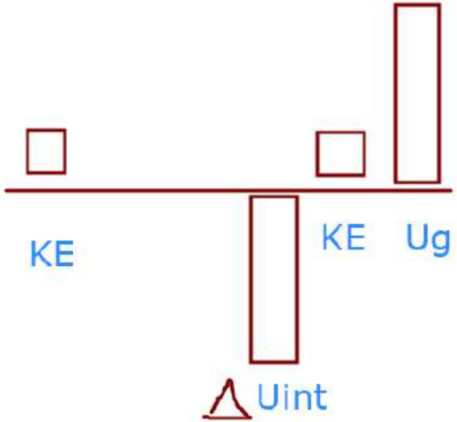
TEAM 2


final
v
nitial
v


Earth & suitcase
KE_i U_{gi} W U_{gf}+KE_f


Suitcase
KEi
wi
Int
KEf


final
v
nitial
v


KE
KE
Ug
ΔUint

Team 3 Modified 7.2.3

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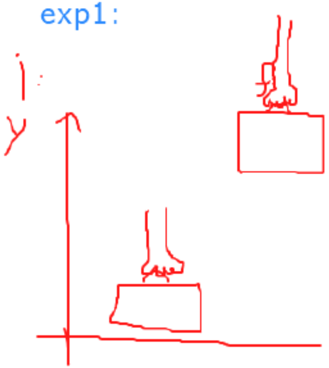
System 1: The suitcase (Earth does work on the suitcase here).

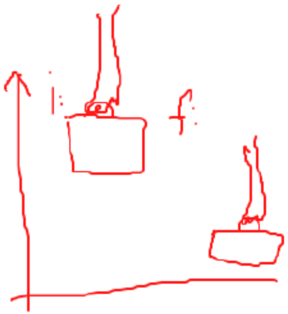
System 2: The suitcase and Earth.

System 3: The suitcase, Earth and you.

exp1:

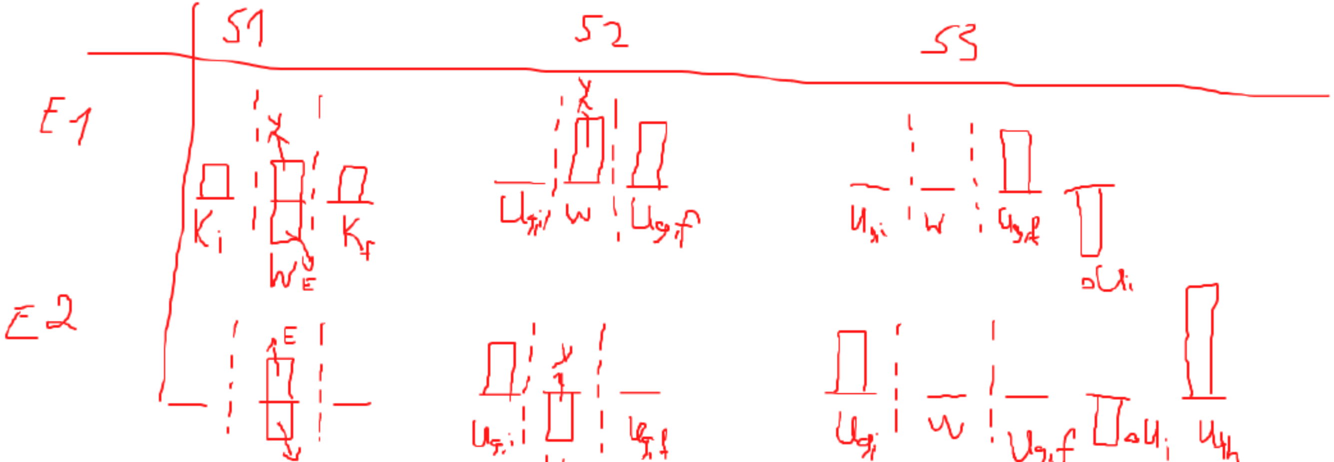


exp 2:



sys1: only the suitcase
sys2: the suitcase+Earth
sys3: s+E+you

we have kinetic energy present but it doesn't change (because v=const) so we won't include.



Team 4 Modified 7.2.3

7.2.3 Represent and reason

Below you read the descriptions of two experiments.

a. Draw a sketch showing initial and final states.

b. Construct a qualitative work-energy bar chart for each of the systems listed below.

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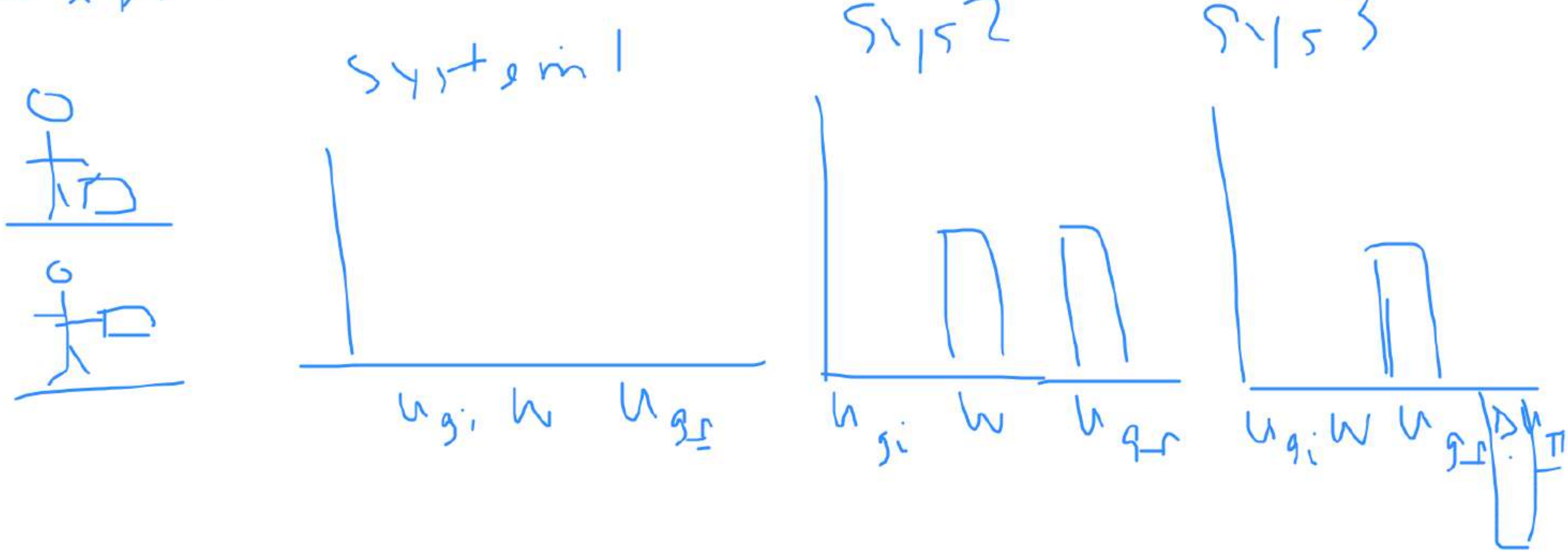
System 1: The suitcase (Earth does work on the suitcase here).

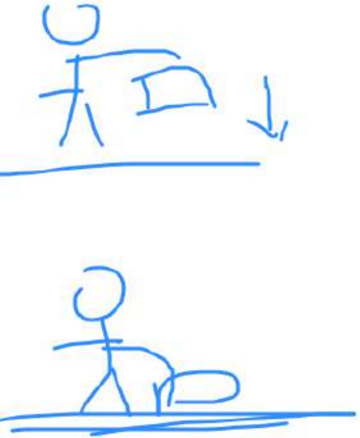
System 2: The suitcase and Earth.

System 3: The suitcase, Earth and you.

Expt 1

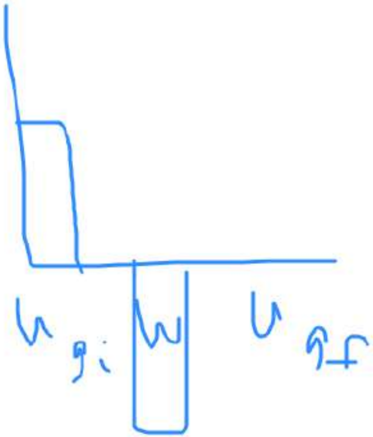


Expt 2

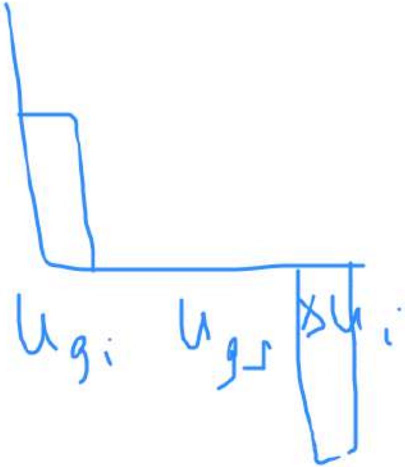


Sys 1

Sys 2



Sys 3



All together 7.2.4

All together: observe the videos Lead sphere and Joule's experiment, choose a system for analysis, initial and final states and draw barch charts.

https://mediaplayer.pearsoncmg.com/assets/_frames.true/sci-OALG-7-5-4

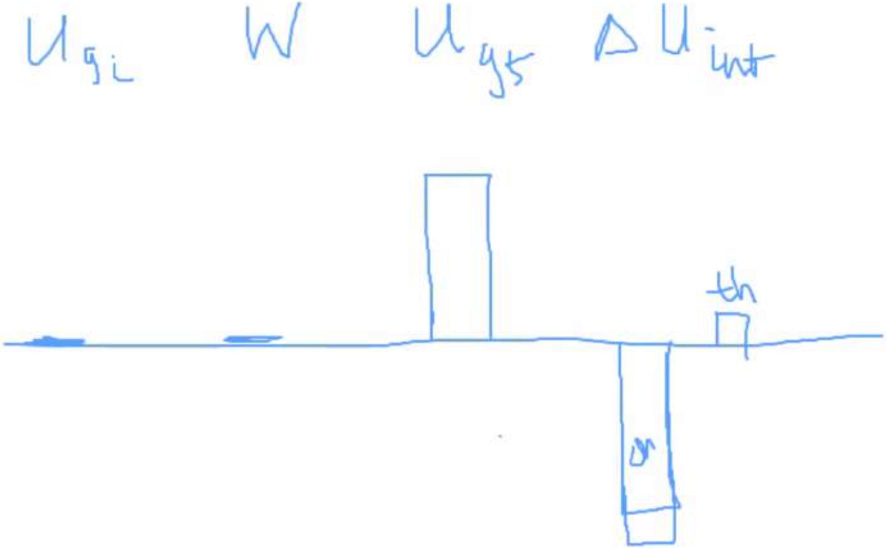
https://mediaplayer.pearsoncmg.com/assets/_frames.true/sci-phys-egv2e-alg-15-3-1

Back to the stairs experiment.

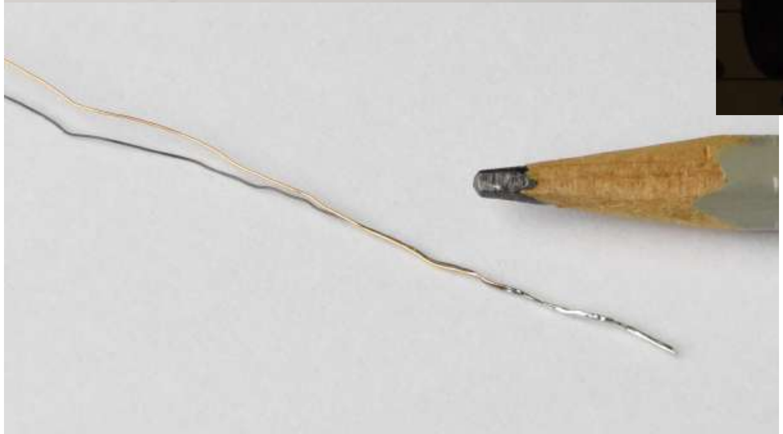
Do stairs do work on you when you go up? Down?

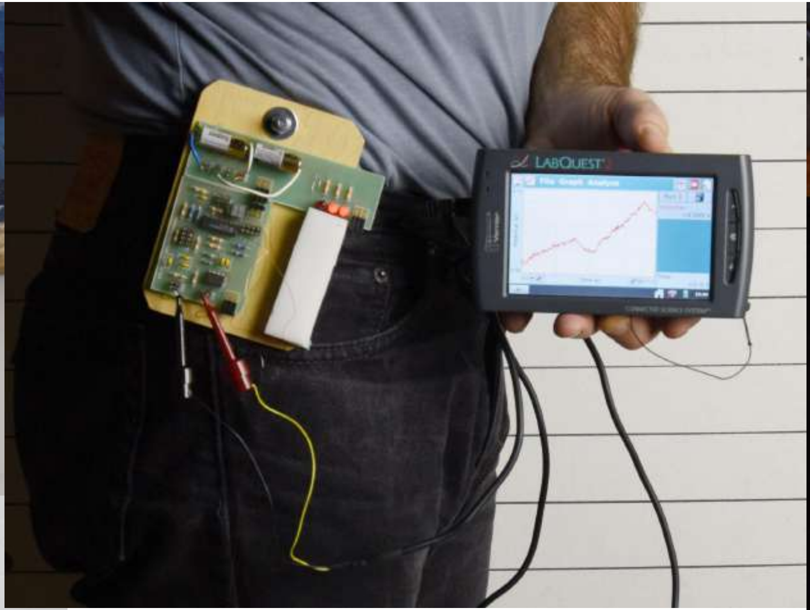
How do we draw a bar chart representing the process? What should be in the system?

Up:

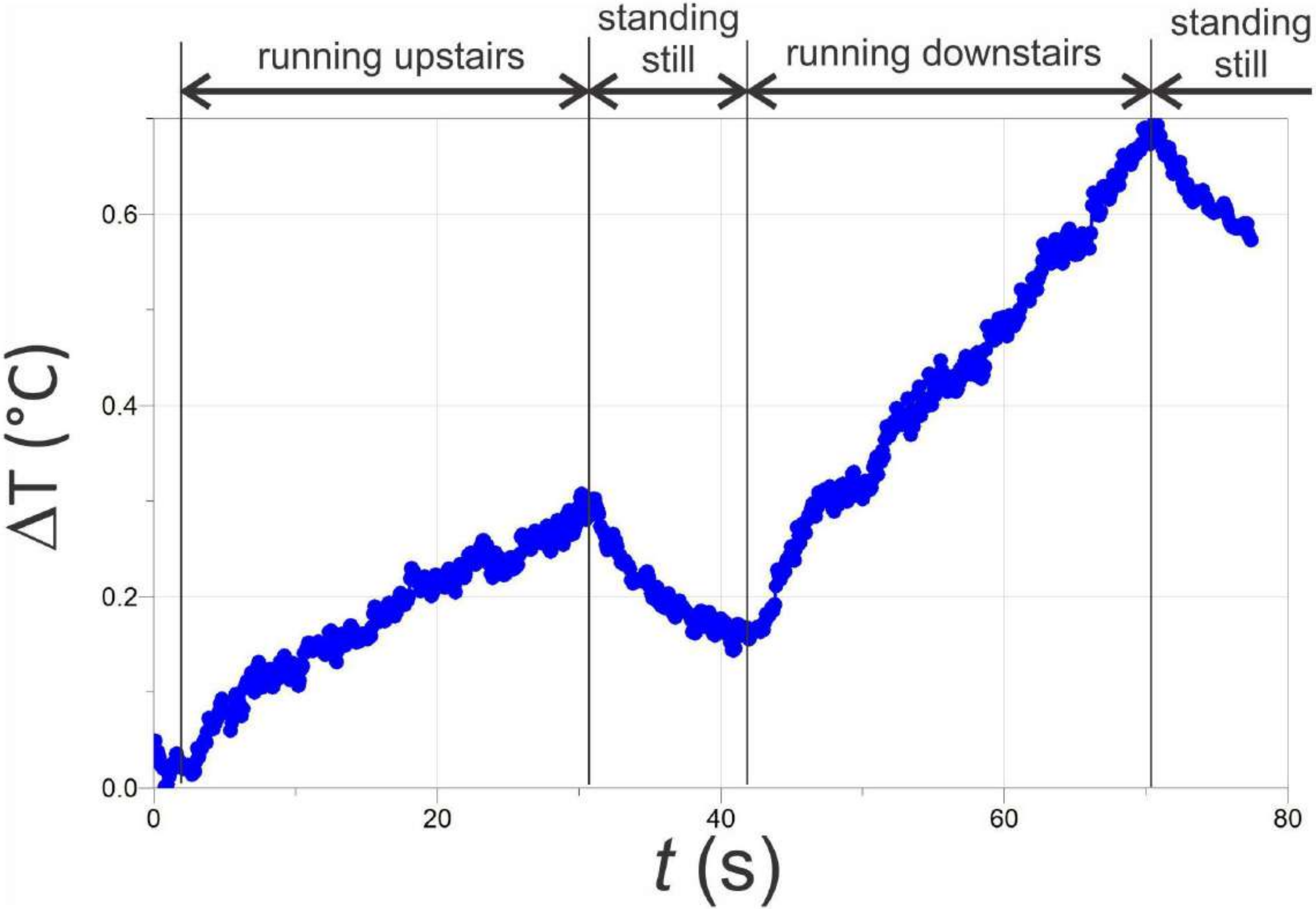


Testing Experiment (Gorazd Planinsic)





Thermocouple in the shoe, LabQuest and amplifier with batteries



running upstairs
standing still
running downstairs
standing still
ΔT (°C)
0.0
0.2
0.4
0.6
0
20
40
60
80
t (s)

Team 1 Use bar charts to represent the process of us going upstairs at constant speed. Earth, the stairs, and the person are in the system.

Team 2 Use bar charts to represent the process of us going upstairs at constant speed. Earth, the stairs, and the person are in the system.

Team 3 Use bar charts to represent the process of us going downstairs at constant speed. Earth, the stairs, and the person are in the system.

Team 4 Use bar charts to represent the process of us going downstairs at constant speed. Earth, the stairs, and the person are in the system.

All together 7.3.1

Team 1 7.3.2 Watch the video only AFTER you made the prediction

https://mediaplayer.pearsoncmg.com/assets/_frames.true/sci-OALG-7-3-2

Team 2 7.3.2 Watch the video only AFTER you made the prediction

https://mediaplayer.pearsoncmg.com/assets/_frames.true/sci-OALG-7-3-2

Team 3 7.3.2 Watch the video only AFTER you made the prediction

https://mediaplayer.pearsoncmg.com/assets/_frames.true/sci-OALG-7-3-2

Team 4 7.3.2 Watch the video only AFTER you made the prediction

https://mediaplayer.pearsoncmg.com/assets/_frames.true/sci-OALG-7-3-2

List the most important things that you learned today

I think making that slide with Team 1 was a real ah ha moment for me about defining different systems for what is traditionally just one scenario.

Bar-charts are very useful representation

Once again, how to build knowledge from experience

Bar-charts need time to master

Internal energy=chemical energy + thermal energy

Show energy by crushing chalk

I gained a better understanding of graph charts, but most importantly I learned how the temperature increases when going down stairs!

Details about internal energy.

Redefining the system is very important

Separate systems but make sure they balance

Impt to do qualitative analysis before quantitative analysis

Definition of system + bar charts very helpful to show students how to view conservation of energy